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Morphometric and General Geomorphological Features of Kilistra (Gökyurt) Region

Dr. Halil Mesut BAYLAK

Çankırı Karatekin Unıversity, hmesutb79@gmail.com Orcid No: 0000-0002-2636-7308

Abstract

The development of cities due to the increase in population, industrial activity, transportation activities, mobility in mining and energy fields, construction in ports and coastal filling areas, and erosion-excavation and accumulation-filling activities that occur as a result of tourism activities cause intense changes in the relief. With developing technology, these processes can be detected, and their distribution and effects can be evaluated with different systematic analyses. The main purpose of the research is to define and evaluate the factors that affect the geomorphology of the areas where people carry out their cultural activities in the universe of Kilistra (Gökyurt) Region. Observation studies were carried out to evaluate the geomorphological formation in the area, which is affected by geomorphological hazards and therefore exposed to risk. A mixed research method was used in the study. Geomorphological and morphometric characteristics of the research area were obtained using the quantitative research method. The data was subjected to meta-analysis and defined for the field.

Anthropogenic effects have accelerated the processes affecting the geomorphology of the study area. In addition, the geomorphological feature of the region has enabled the use of the area by the local people as a result of cultural activity and increased erosion. For example; It has enabled tuffaceous land to be used for human activities such as allowing it to be used for defense purposes, allowing the construction of religious elements (such as chapels, churches, etc.), and being used for purposes such as cellars or dwellings. Today, these landforms continue to be used as haystacks, warehouses and barns.

Keywords: Kilistra, Gavur Caldera, Nek, Gökyurt Mesa

Introduction

With today's developing technology, starting with the Industrial Revolution, gigantic artificial landforms have been formed in the natural environment, and while the change was small in size at the beginning, it has reached large dimensions recently (Jefferson et al. 2013:1). The development of cities due to the increase in population, industrial activity, transportation activities, mobility in mining and energy fields, and erosion–excavation and deposition-filling activities resulting from construction in ports and coastal filling areas as well as tourism activities cause intense changes in the relief (Erkal and Taş, 2013, p.209; 2022, p.177). Because of the advancing technologies, these processes can be detected and their distribution and impacts can be evaluated through different systematic analyses.

The evaluation of the effects of human activity that damage or sometimes destroy the area they live in can be considered as acculturation or civilization. The components that embody the cultural characteristics of a region and their interactions with the landscape features form the cultural heritage. Based on this statement, the increasing destruction of nature along with the exponential increase in the population in the last century has led to the development of the idea of conserving the nature and preserving the natural heritage. Thus, the negative consequences of the destruction are should be considered as a global threat, and a common attitude should be adopted to mitigate the consequences. In response to the rapid devastation or destruction of nature, it has become essential to protect the natural environment.

Objective and Method

The main objective of the research is to identify and evaluate the factors that affect the geomorphology of the areas where people maintain their cultural activities in the Kilistra (Gökyurt) Region. Observation studies have been carried out to evaluate the geomorphological formation in the region that is affected by geomorphological hazards and therefore exposed to geomorphological risk.

A mixed research method was used in the study. The geomorphologic and morphometric characteristics of the study area were obtained using the quantitative research method. The data were subjected to meta-analysis and defined for the field.

The geological and geomorphological features of Kilistra (Gökyurt) region have had an impact on the formation of archaeological deposits in the area. Geomorphological features have influenced the distribution of prehistoric sites.

The environmental components are relatively consistent with the geomorphological features prevailing in the area. This is important for evaluating geomorphology as a sustainability factor in the natural environment as well as the development and diversification of the parameters that are effective in the environment. Climate, vegetation, soil structure, and hydrogeography are effective in this. The development of the environment has also played a key role in the shaping and interpretation of the site as a cultural seat since the ancient times.

Location of the Research Area

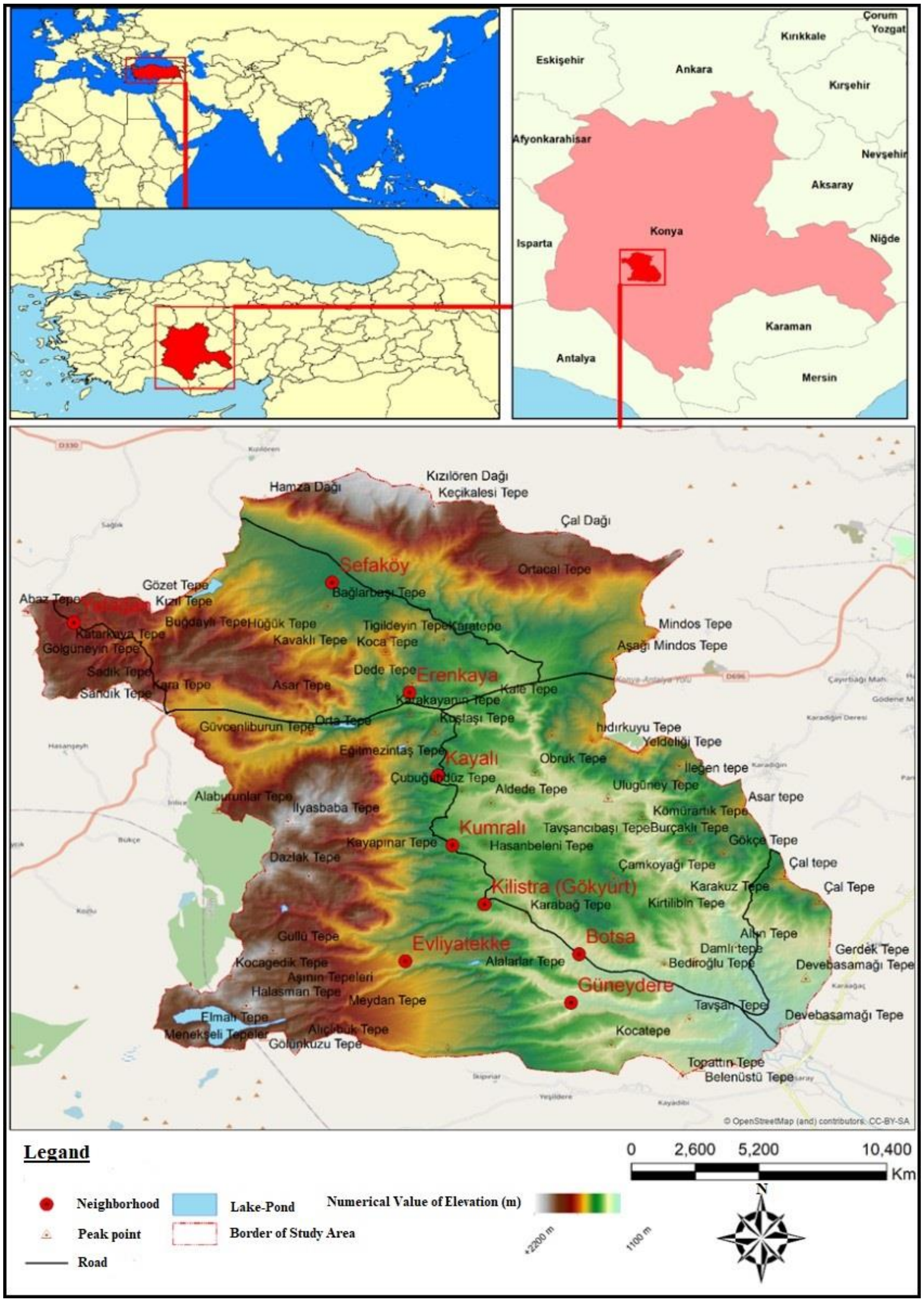
Kilistra (Gökyurt) region and its immediate surroundings, located within the borders of Meram district of Konya province and have been used as a settlement area since ancient times, were selected as the study area (Figure 1). The study area covers approximately 549.8 km^2. The residential areas in the area are Gökyurt, Kayalı, Erenkaya, Kumralı, Yatağan, Sefaköy, Güneydere (Botsa), and Evliyatekke neighborhoods.

Located in Meram district of Konya province, the study area is surrounded by Kızılören Mountain, Çal Mountain, Keçikalesi Hill to the north; Çal Hill and Midos Hill to the east; Sadık Hill, Güvenliburun Hill, Alaburunlar Hill, Dazlak Hill and Kovagedik Hill to the west; and Menekşeliler Hill, Gölünkuzu Hill, Alıçlıbük Hill, Topattın Hill and Hatunsaray Plain to the south (Figure 1).

The study area was designated as Urban Archaeological Site, Urban Protected Area, 1st and 3rd Grade Archaeological Site by the decision of the Regional Board for the Preservation of Konya

Provincial Cultural Heritage dated 29.04.2016 and numbered 3605, whereby the principles of preservation and conditions of use have also been determined.

Figure 1. Research Site location map (Baylak, 2023).



Findings

Kilistra (Gökyurt) Region is located in the eastern part of the Erenler–Alacadağ volcanic mass, which is the continuation of the northern slopes of the Taurus Mountains facing Central Anatolia, to the south of Loras Mountain. The main geomorphologic units are mountainous and hilly areas, lowland areas in the southeast and northwest, and plateau areas between these two.

Most of the study area is composed of tuffs, agglomerates, and andesites formed during the Upper Miocene–Pliocene period. This lithological structure is reflected in geomorphology as the formation of different landforms. Cornices and deep valleys were formed in areas where basalts and andesites were found (Figure 2).

The site is generally remarkable in that the impacts of topographic elements of volcanic and fluvial morphology and the anthropogenic activities on the process can be evaluated together (Figure 3).

The elevation generally increases in the northern, northwestern, and western parts of the region. Elevation data show a decrease in the southeastern part of the region, whereas it increases relatively in the central part due to the presence of plateau area (Figure 4).

Figure 2. Cornices formed by the basalt formation on the slopes of the valley of Botsa Stream.

The slope in 30% of the study area is 5%–10%. However, the slope reaches 20%–25%, particularly in the mountainous and hilly parts such as Hamza Mountain, Kızılören Mountain, Keçikalesi Hill and Çal Hill in the north, which forms the south skirts of Loras Mountain, and Dazlak Hill in the northwest and west; furthermore, it reaches >25% in some places. The cornices on the valley slopes of the mountainous areas have the highest slope value (25%) whereas the alluvial plain in the southeast has the lowest slope value with 0%–5% (Figure 5).

Figure 3. Cultural Geomorphology Map of Kilistra (Gökyurt) Region

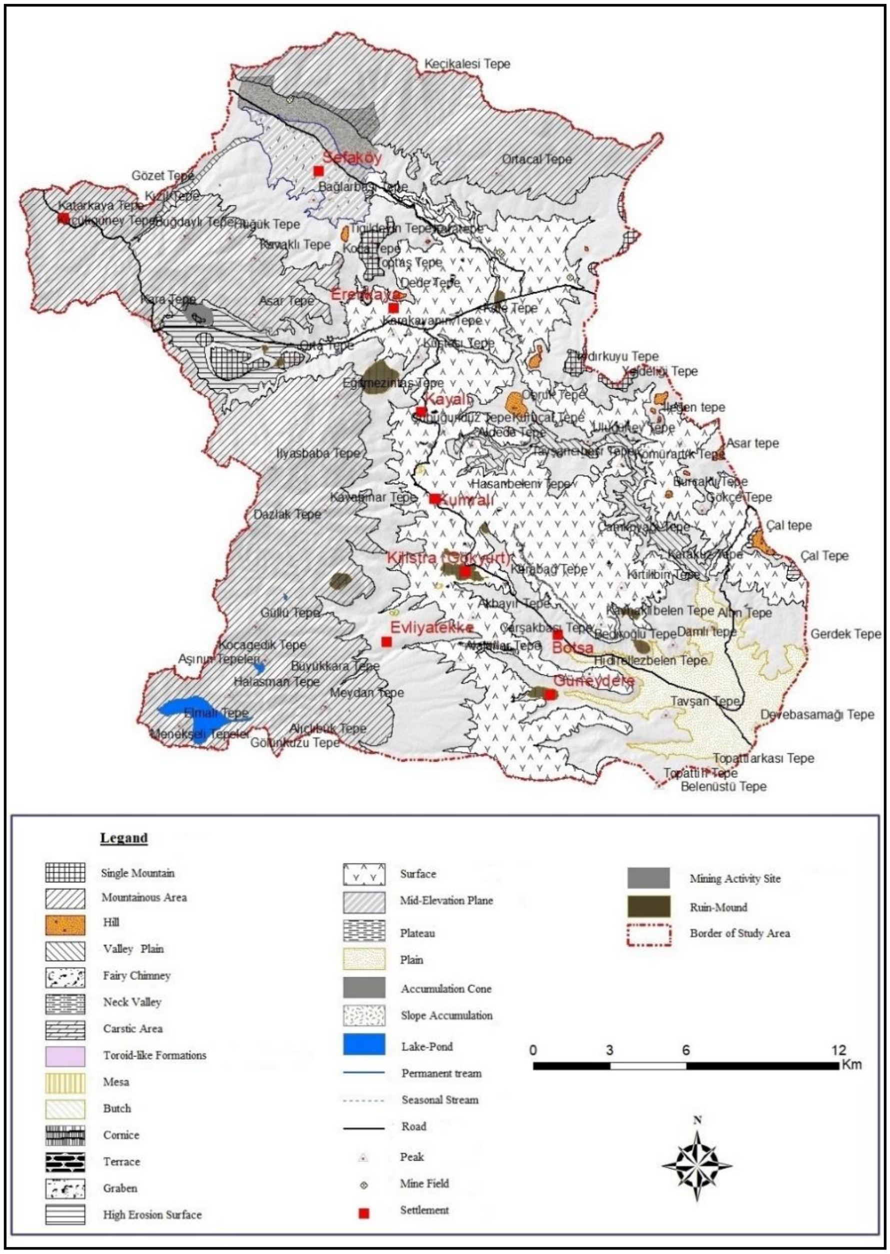
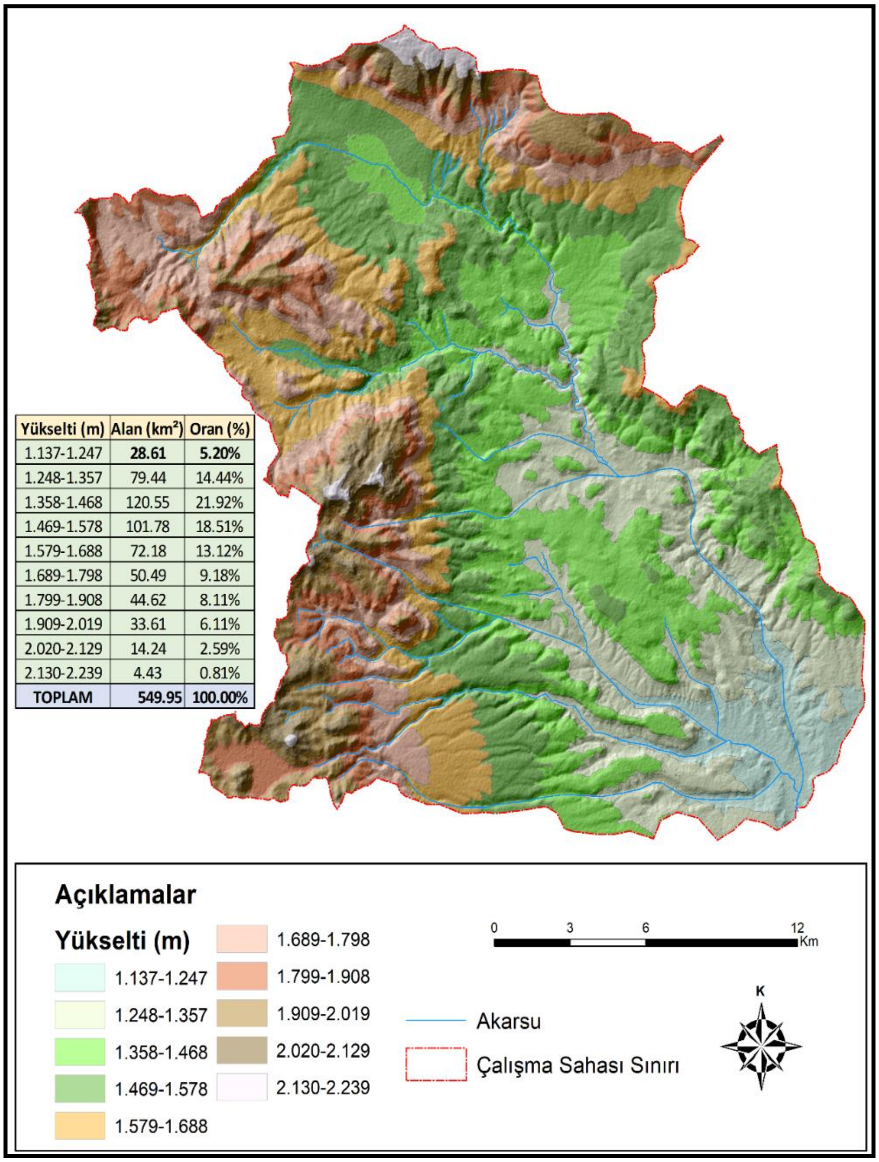
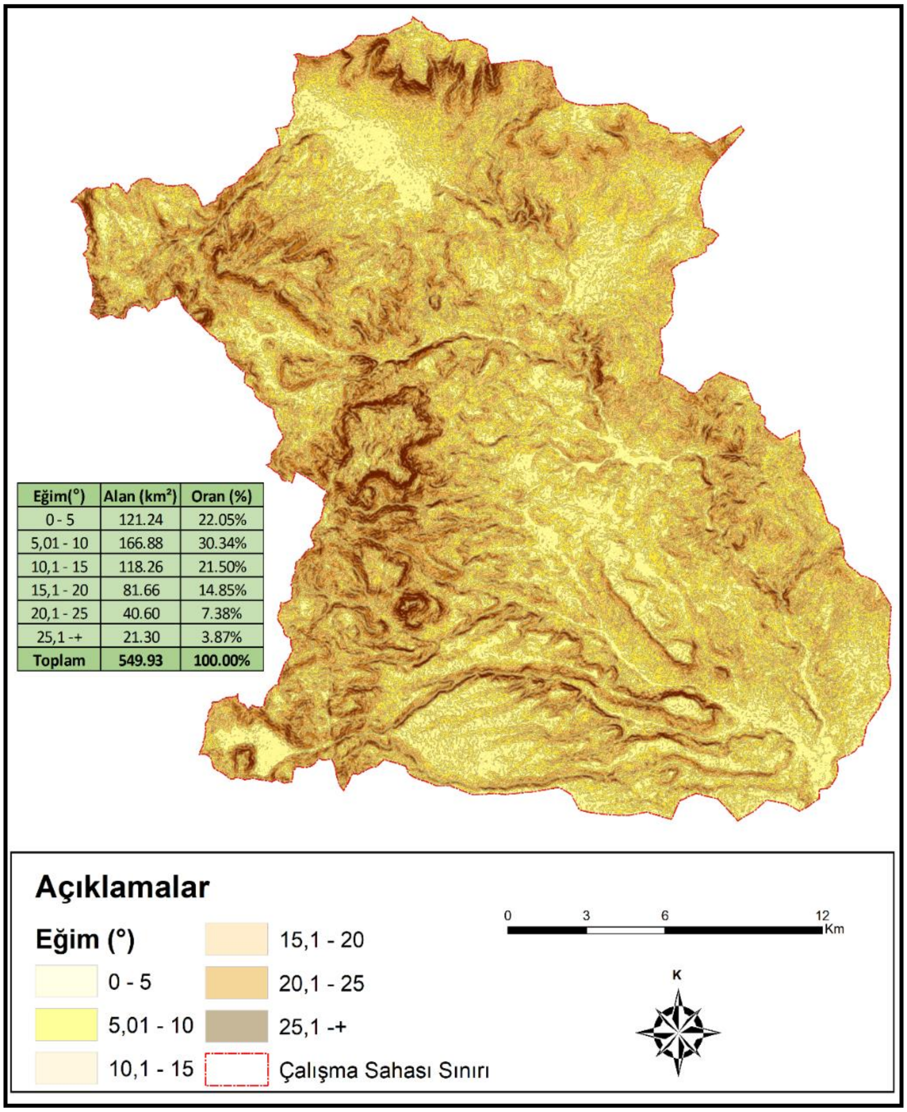


Figure 4. Elevation map of the study area



Yükselti (m)	Alan (km²)	Oran (%)
1.137-1.247	**28.61**	**5.20%**
1.248-1.357	79.44	14.44%
1.358-1.468	120.55	21.92%
1.469-1.578	101.78	18.51%
1.579-1.688	72.18	13.12%
1.689-1.798	50.49	9.18%
1.799-1.908	44.62	8.11%
1.909-2.019	33.61	6.11%
2.020-2.129	14.24	2.59%
2.130-2.239	4.43	0.81%
TOPLAM	549.95	100.00%

Figure 5. Slope map of the study area



Eğim(°)	Alan (km²)	Oran (%)
0 - 5	121.24	22.05%
5,01 - 10	166.88	30.34%
10,1 - 15	118.26	21.50%
15,1 - 20	81.66	14.85%
20,1 - 25	40.60	7.38%
25,1 -+	21.30	3.87%
Toplam	**549.93**	**100.00%**

Mountainous Areas

Mountains in the region (Kızılören Mountain, etc.) have been affected by the Alpine Orogeny and subsequent epeirogenic movements, and they have gained a fractured and folded structure, thereby attracting attention with their elevations.

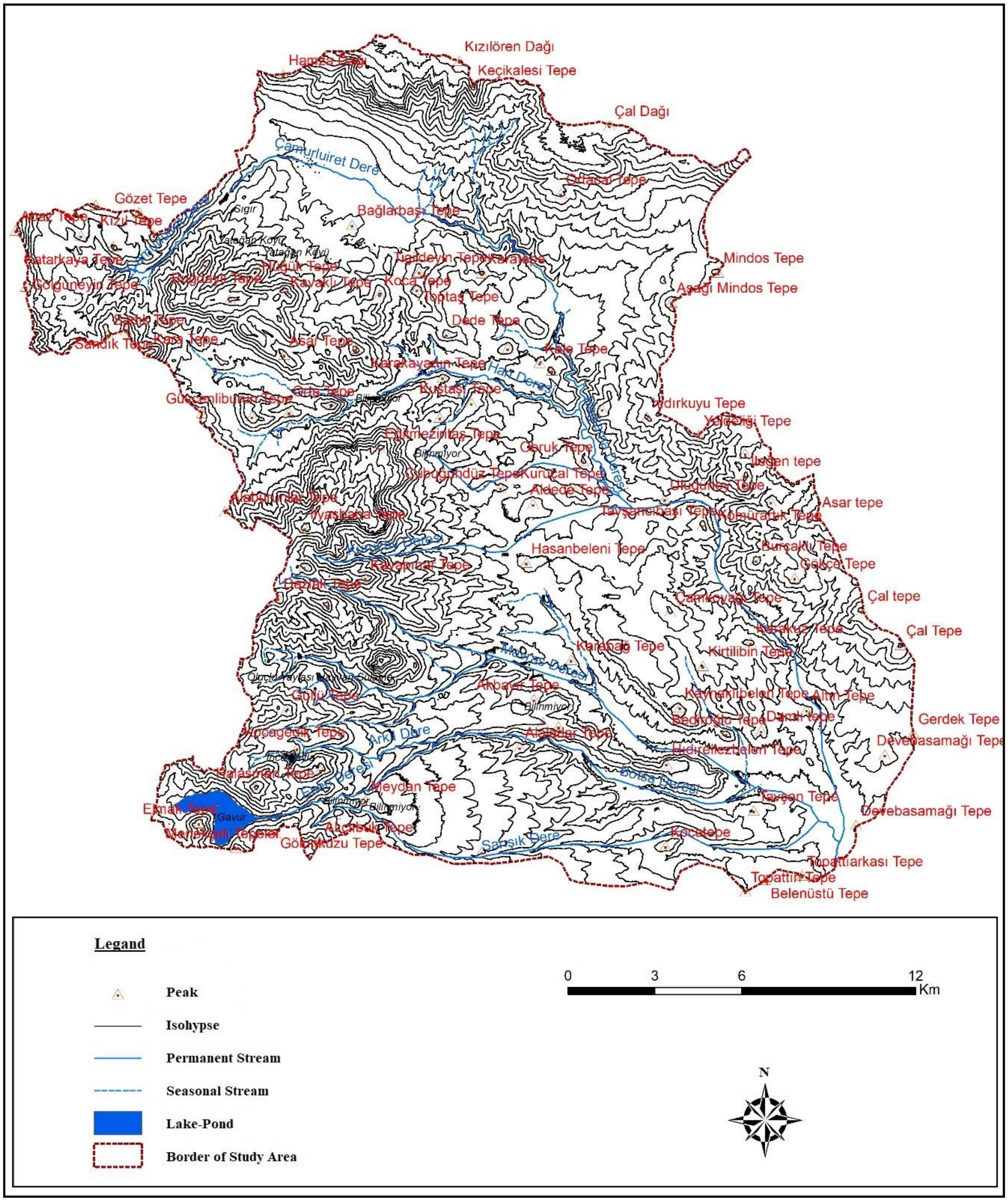
The main mass forming the mountainous areas is Erenler–Alacadağ volcanic mountain belt. The Alacadağ section surrounds the west of the basin. It has been determined through studies that Alacadağ was formed as a result of volcanism that started in the Middle Miocene and continued until the Pliocene period (Keller et al., 1977; Ulu et al., 1994).

This mountainous area is mostly composed of andesitic and trachyandesitic rocks and is lined with tuff and tuffite sediments (Akkuş-Bozyiğit, 2000). Neck formations are present around mountainous and hilly areas (Figure 2.11).

Figure 2.11. Neck formation in Güneydere (Botsa) neighborhood

The fact that the lava coming to the surface as a result of volcanic activity in the western part of the region was not that fluid has been effective on high elevation of the hills. In the study area, especially Halasman Hill (2161 m), Dazlak Hill (2142 m), İlyasbaba Hill (2019 m), Güllü Hill (2057 m), and Elmalı Hill (2054 m) are remarkable. Kızıltepe Hill, Abaz Hill, Küçükgüney Hill, Katarkaya Hill, Gölgüneyin Hill, Sandık Hill, Sadık Hill, Kara Hill, Güvcenliburun Hill, Alaburunlar Hill, Kayapınar Hill, Kocagedik Hill and Büyükkara Hill are other important elevations (Figure 2.12).

Figure 2.12. Map of Kilistra (Gökyurt) Region’s contour curves



Gâvur Caldera

Gâvur Caldera is within the study area. Biricik (1982) estimated the caldera's dimensions to be 3000-m long and 1850-m wide whereas Bozyiit and Güngör (2011) calculated it to be 2500-m long and 2000-m wide. As a result of the field study and through the model created using ARCGIS software, conducted within the scope of this study, the caldera was measured 2805-m long and 1910-m wide. Elmalı Hill, Halasman Hill, Gölünkuzu Hill and Menekşeli Hill surround the caldera area. The relative elevation difference between the caldera floor and the surrounding hills was determined to be 185 m on average.

On the sides, overlooking the caldera floor, of the hills that surround the caldera, the slope values are >60° in the northeast, southeast, and south, and reach up to 35°–40° in the west and north, despite vary slightly. There are springs with different flow rates on the caldera floor. At the floor of Gâvur Caldera is Lake Gâvur, whose area varies annually depending on seasonal conditions (Bozyiğit and Güngör, 2011). Although defined as a lake, it would be appropriate to regard it as a pond due to the dykes built for the accumulation of shallow water. Although the mirror surface area of the lake varies depending on annual and seasonal conditions, it has a length of 1500–1700 m in the E–W direction and a width ranging between 500 and 1700 m in the N–S direction.

Plateau Field

In the study area, there are plateau areas formed at different elevations, which also correspond to erosion surfaces. The plateau areas of Kilistra (Gökyurt) Region were formed as a result of both tectonic events and current erosion since the Upper Pliocene. There are high and low plateau areas in the basin, separated from each other by significant elevation differences.

The plateau surfaces exhibit a fractured feature due to the characteristics of the volcanic formation as well as impact of the tectonic activity. Tuff, agglomerate, and sandstone caused the valley density to increase. The formations that make up the lithological structure of the plateau area are mostly composed of Miocene–Pliocene-aged limestone, sandstone, tuff, agglomerate, marl, and andesitic lavas. The units are horizontally positioned. The fluvial activity that is effective on the slopes of the hills, which were formed by the volcanic activity in the plateau and its vicinity, has led to the formation of badlands and fairy chimneys.

The high erosion plain developed at elevations between 1250 and 1700 m. The plateau area, shaped by rivers and surface erosion, is fragmented by steep-slope valleys developed in line with the slopes of the strata. The plateau surface extends toward the lowland area in the form of plains with slopes ranging between 5° and 10° (See. Figures 2.9 and 2.10).

Fairy Chimneys

Fairy chimneys, formed as a result of both lithological features and different erosion mechanisms, are visible on the slopes of the valley. The fairy chimney formations particularly in Kilistra (Gökyurt), Botsa, and Erenkaya are remarkable. Ignimbiritic tuffs lie horizontally on the valley slopes where the streams flow. As such, cornices are visible on the slopes of the valley. In addition, some high plains have gained a butch appearance. Gökyurt (Kilistra) Neighborhood is located on a mesa extending in the northwest–southeast direction. The plain, named "*Gökyurt Mesa*" in this study, is separated by steep slopes from the valley floor of the Aşın Stream and its branches. The tuffaceous land, in regards to the human activities, was used for different purposes such as churches, cellars, and dwellings. Today, it continues to be used as hayloft, store house, and barns(Figure 2.13). This situation increases anthropogenic erosion in the area.

Figure 2.13. A view of anthropogenic erosion northwest of Kilistra (Gökyurt) neighborhood

Lowland Areas

The plain in the vicinity of Sefaköy, which occupy a large area in the southeastern part of the site, have developed under the influence of tectonic and fluvial conditions. The area has taken on a plain appearance by means of accumulation of alluvium from the streams, characterized with flood regime, in the area (Figure 2.14). The streams flows through a broader bed along the valley floor after the confluence of the branches (Figure 2.15). The valley floor contains young alluvium. Alluvium thickness varies between 2–4 meters (Bozyiğit and Güngör, 2011). The accumulation at the bottom of the plain consists of gravel, sand, silt, and mudstones in some places.

Figure 2.14. Sefaköy plain area formed by the accumulation of alluvium from the foothills of Loras Mountain in the north

Source: (meramsefaköy.net)

Figure 2.15. Lowland area extending southeast toward the Lystra mound

Kaynak: (https://drivethruhistoryadventures.com).

Erosion

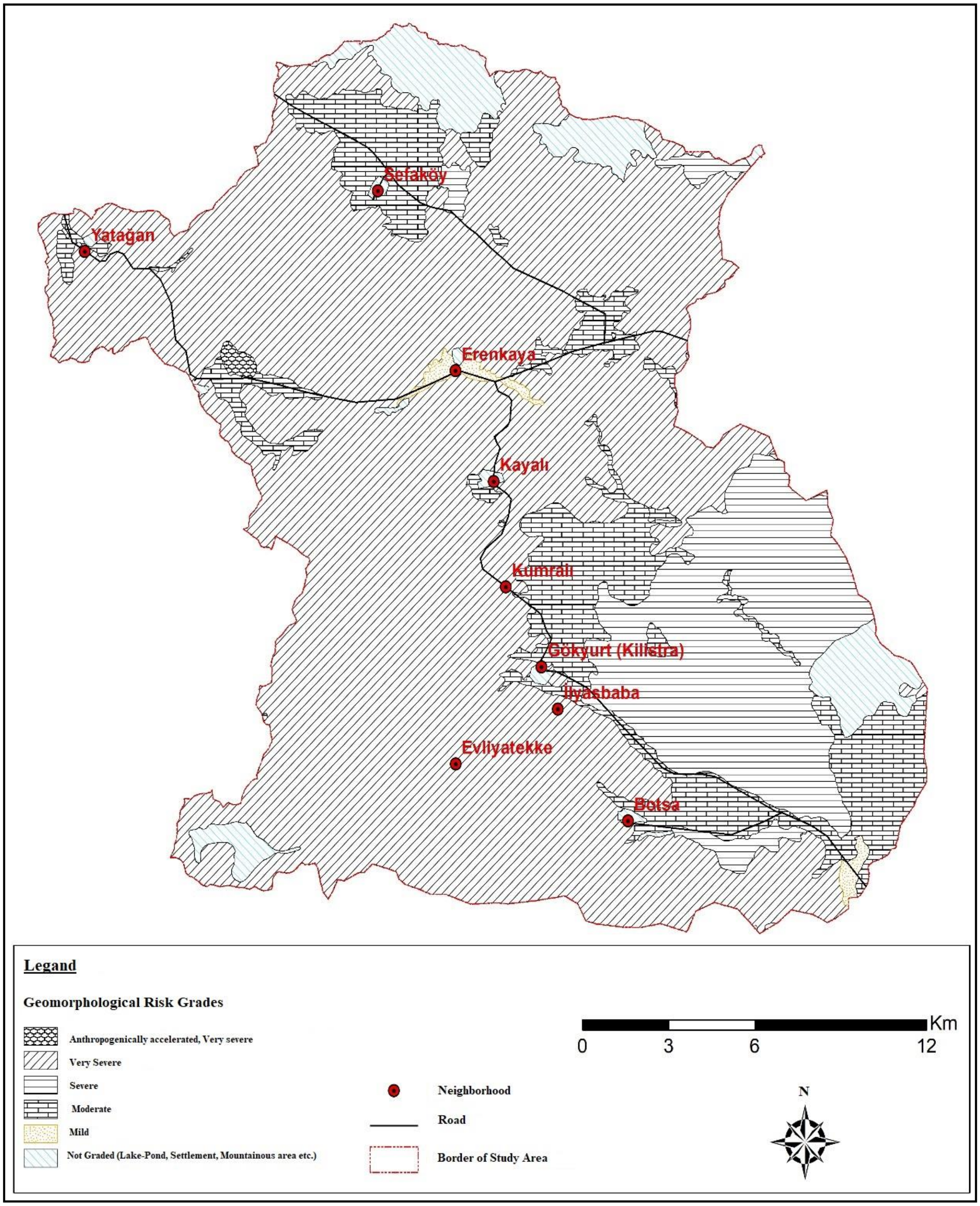
The human activities and their consequences on the geomorphology need to be evaluated in areas where such activity has been present for a long time. When the physical geography of the study area and human activities are evaluated together, it is observed that active "*geological erosion*" and "*cultural erosion*," as well as sediment transport have been present in the area (Figure 2.16).

Water erosion constitutes the current type of erosion in the region. Considering the shaping effect of erosion, different types of water erosion can be seen. Raindrop erosion, which is the initial stage of erosion, is concentrated in sloping areas with little vegetation cover, particularly in the areas around the Erenkaya neighborhood, where Upper Miocene–Pliocene-aged clayey limestone, marl, and tuff are common.

The most frequently observed erosion type in the study area is gully (finger) erosion. It develops with the deepening of the small beds that have already formed by the surface flow of the waters in the areas, particularly of marl, where slopes increase. In areas where no measures are taken, these small beds turn into gullies (flood gully).

The large amount of volcanic material in the area, the scarcity of the area covered with vegetation, streams with flood regimes, and human activity are the factors that increase erosion. As a consequence of this, the badlands and fairy chimneys formations are frequently seen.

Figure 2.16. Geomorphological risk map of the study area

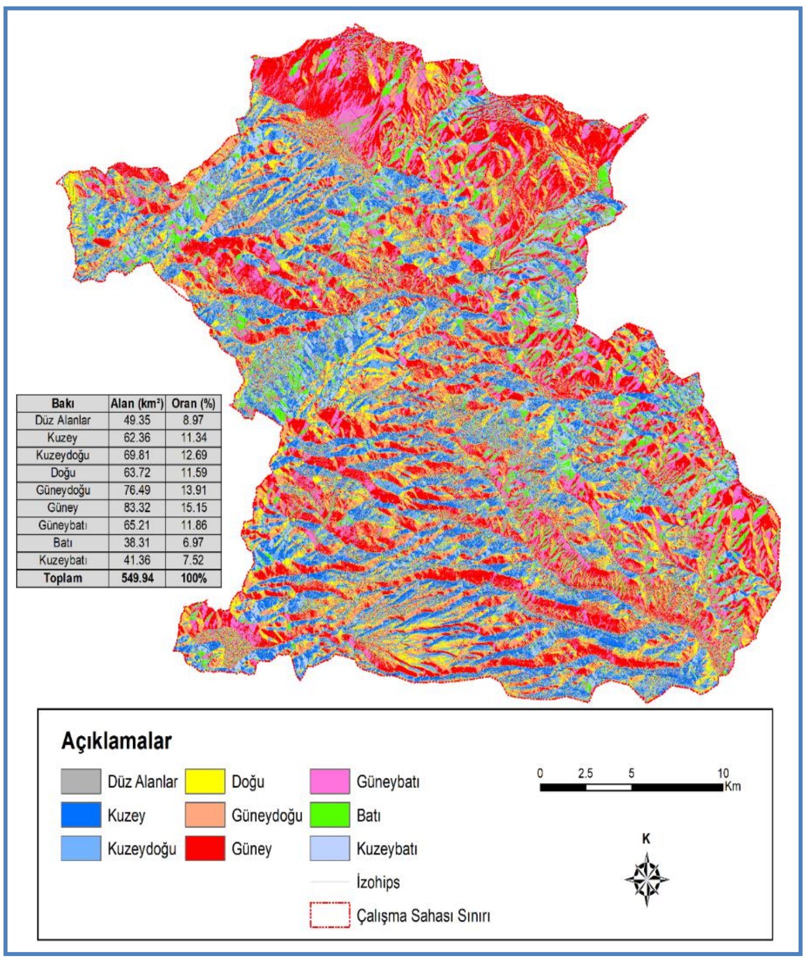

Sefaköy
Yatağan
Erenkaya
Kayalı
Kumralı
Gökyurt (Kilistra)
İlyasbaba
Evliyatekke
Botsa
Legand
Geomorphological Risk Grades
Anthropogenically accelerated, Very severe
Very Severe
Severe
Moderate
Mild
Not Graded (Lake-Pond, Settlement, Mountainous area etc.)
Neighborhood
Road
Border of Study Area
Km
0
3
6
12
N

Morphometry Analysis of the Kilistra (Gökyurt) Basin

Morphometric analysis maps were prepared to obtain quantitative and qualitative data to study the hypsometric and lateral organization of the land surface in the field as well as the morphological features of the geomorphosites and evaluate the relationship between different environmental factors and the geological and geomorphological features of the site. In this context, HGM 5m DEM data, hydrographic data from Konya IV, Regional Directorate of DSI (State Hydraulic Works, SHW), and survey analysis reports of the study area were obtained, analyzed, mapped, and interpreted.

The erosion cycle evident in the field is inclined toward the south, and the main direction effective in the development of the topography was determined to be to the south at a rate of 15.15% (Figure 2.17).

Figure 2.17. Study area aspect map

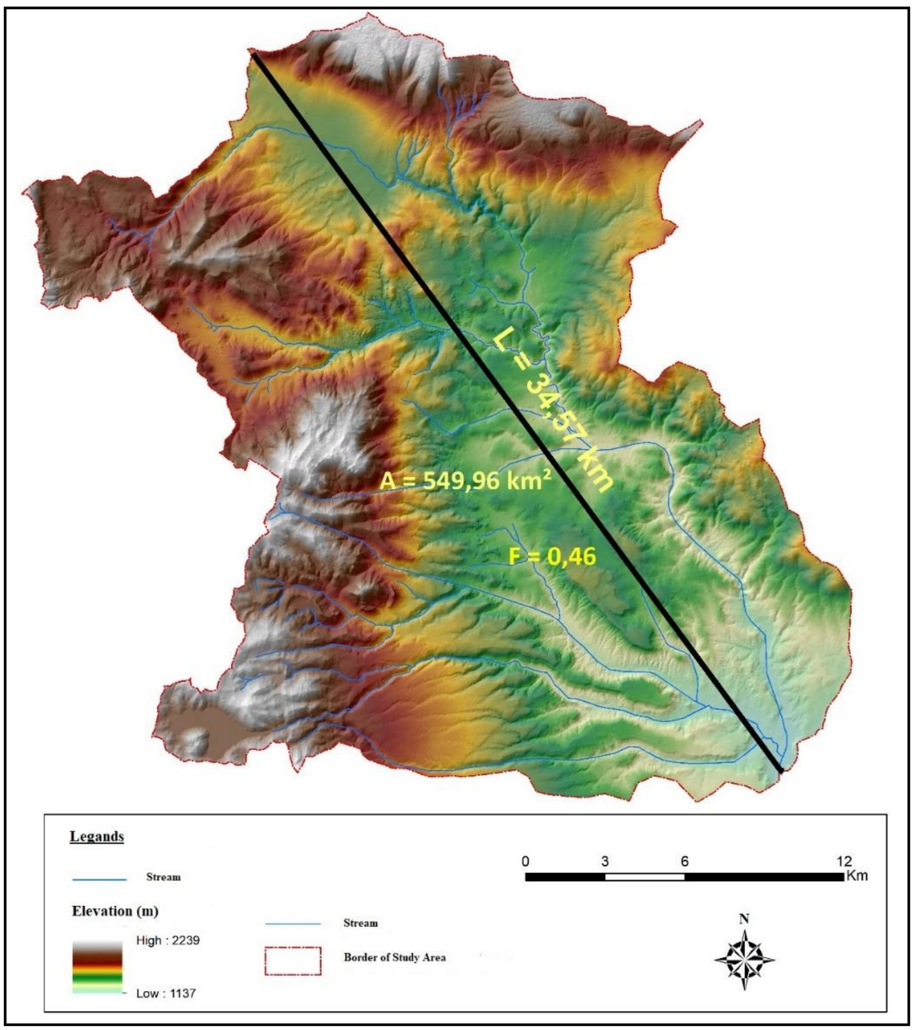


Bakı	Alan (km²)	Oran (%)
Düz Alanlar	49.35	8.97
Kuzey	62.36	11.34
Kuzeydoğu	69.81	12.69
Doğu	63.72	11.59
Güneydoğu	76.49	13.91
Güney	83.32	15.15
Güneybatı	65.21	11.86
Batı	38.31	6.97
Kuzeybatı	41.36	7.52
Toplam	**549.94**	**100%**

The sharp change in slope and the substantial variation of slope on the southern slopes of the basin is attributed to the tectonic activity in the transverse profile line. Basaltic material surfacing along the tectonic lines is more exposed to fluvial and climatic influences on the southern slopes. This condition causes the slope difference in the southern parts to be high.

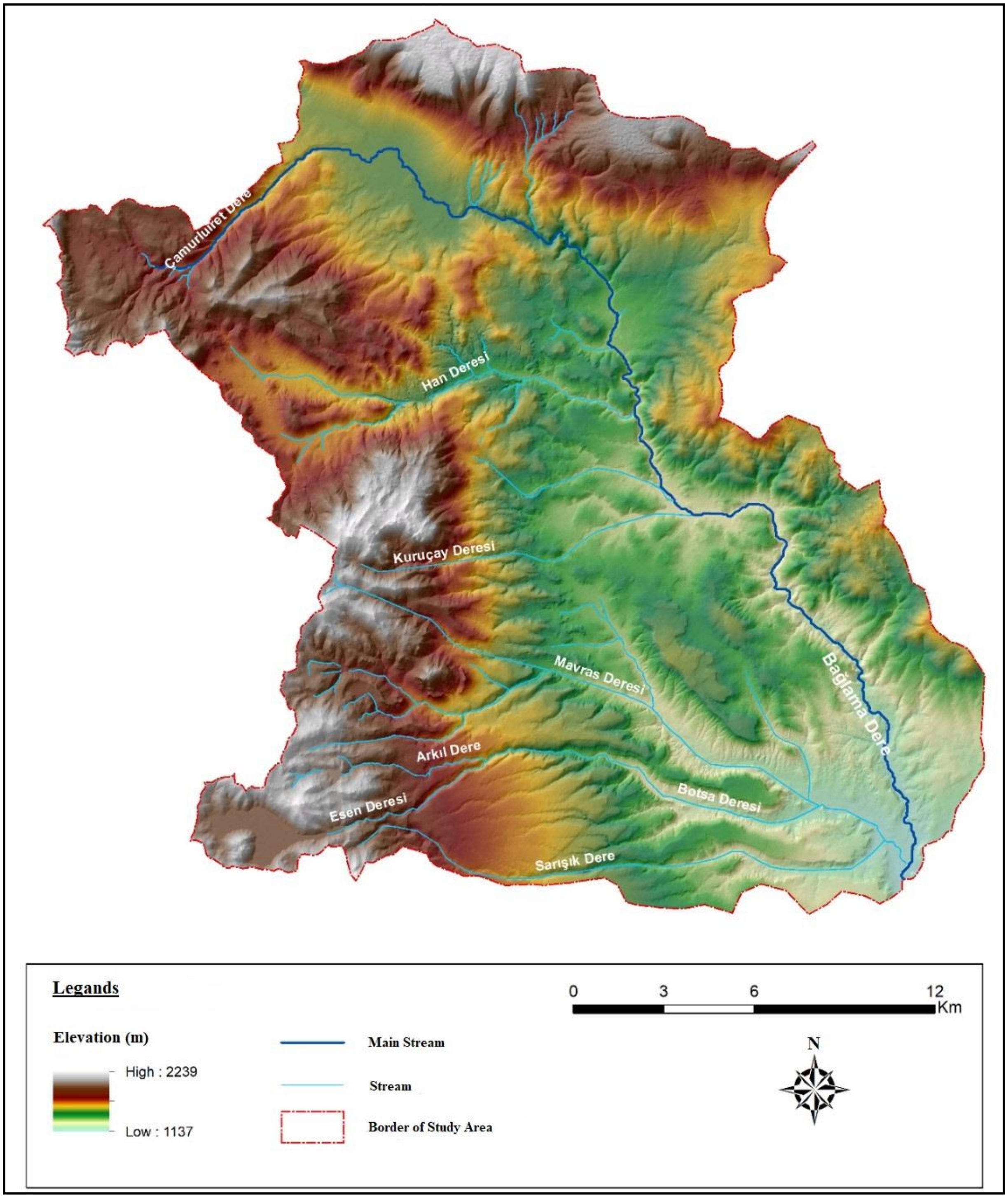
The highest elevation of the site is 2239 m, whereas the lowest elevation is 1137 m, resulting in an average elevation of 1557 m. The study area is 549.9 km² and its perimeter is 132.519 km (Figure 2.18).

Figure 2.18. Basin area and length of the study area



Depending on the general slope and elevation distribution of the area, the permanent and seasonal streams flowing in the E-W direction in the form of branches feed the Bağlama Stream, which becomes the main stream with a length of 50.56 km (Figure 2.19).

Figure 2.19. Main stream map of the study area



Kilistra (Gökyurt) Basin has the proportions of a longitudinal basin sequence. Water is retained less in the basin and drains quickly (Figure 2.20).

Basin streams generally have an overflow character with a low bifurcation rate. However, in the area between Topattıarkası Hill and Devebasamağı Hill, where the branches confluence and leave the study area, it reaches a high bifurcation rate and gains flood character (Figure 2.21).

Figure 2.20. Basin length ratio (RI) map of the study area

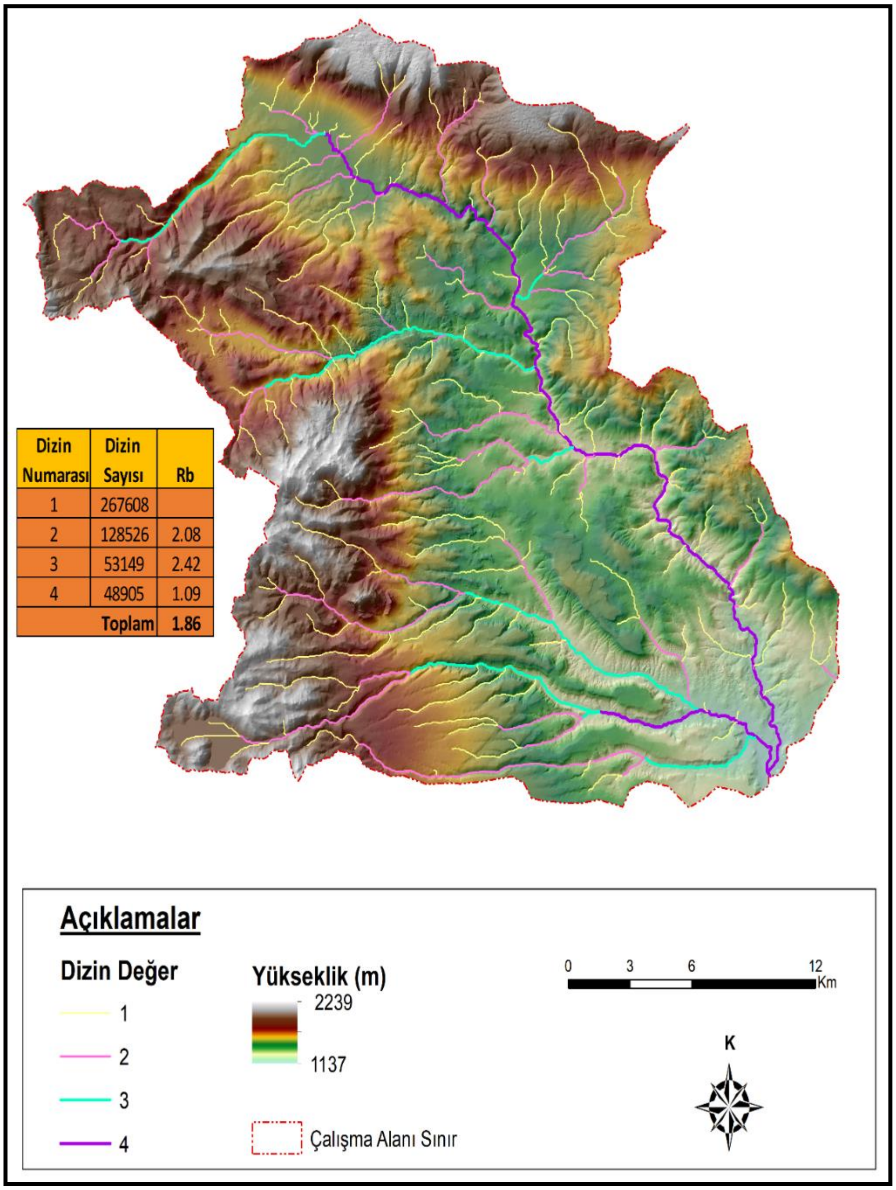
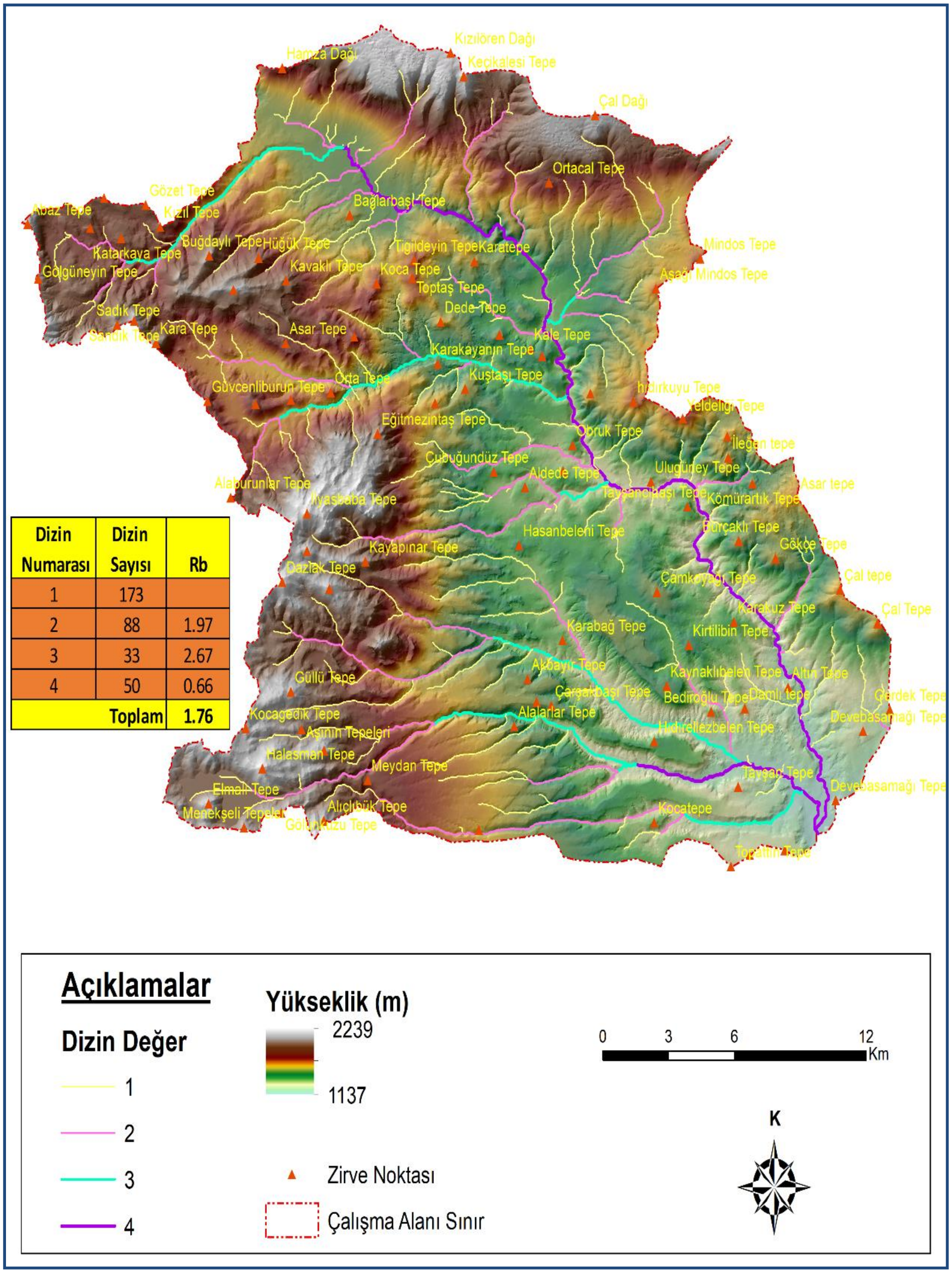


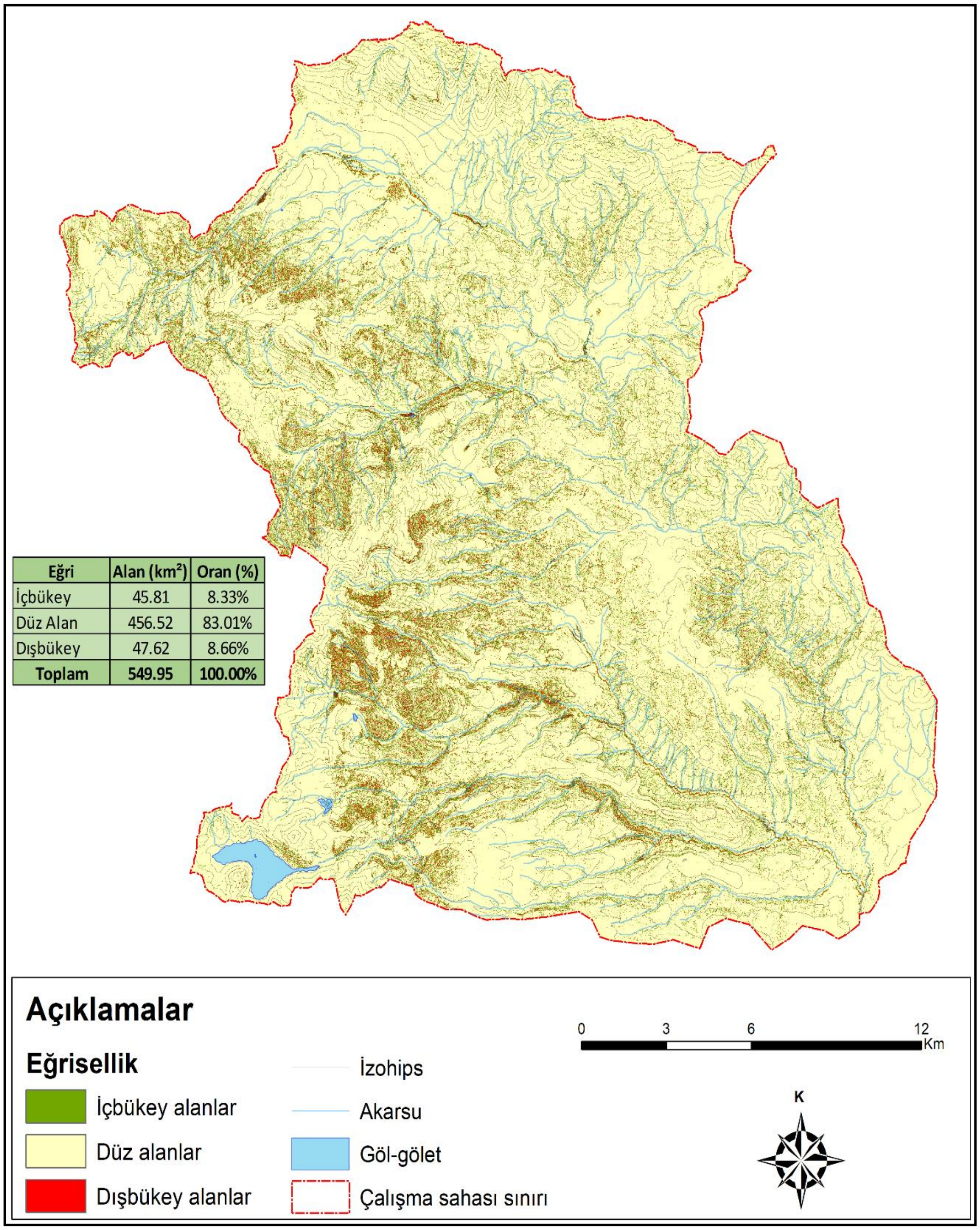
Figure 2.21. Basin bifurcation ratio (Rb) map of the study area



Dizin Numarası	Dizin Sayısı	Rb
1	173	
2	88	1.97
3	33	2.67
4	50	0.66
	Toplam	1.76

Kilistra (Gökyurt) Basin exhibits a flat slope feature with a curvature rate of 83.01%. An area of 47.62 km² of the basin exhibits a convex curvature feature. These areas are where the neck valleys manifest themselves in the topography. 8.33% of these areas have a concave structure (Figure 2.22).

Figure 2.22. Basin curvature map of the study area



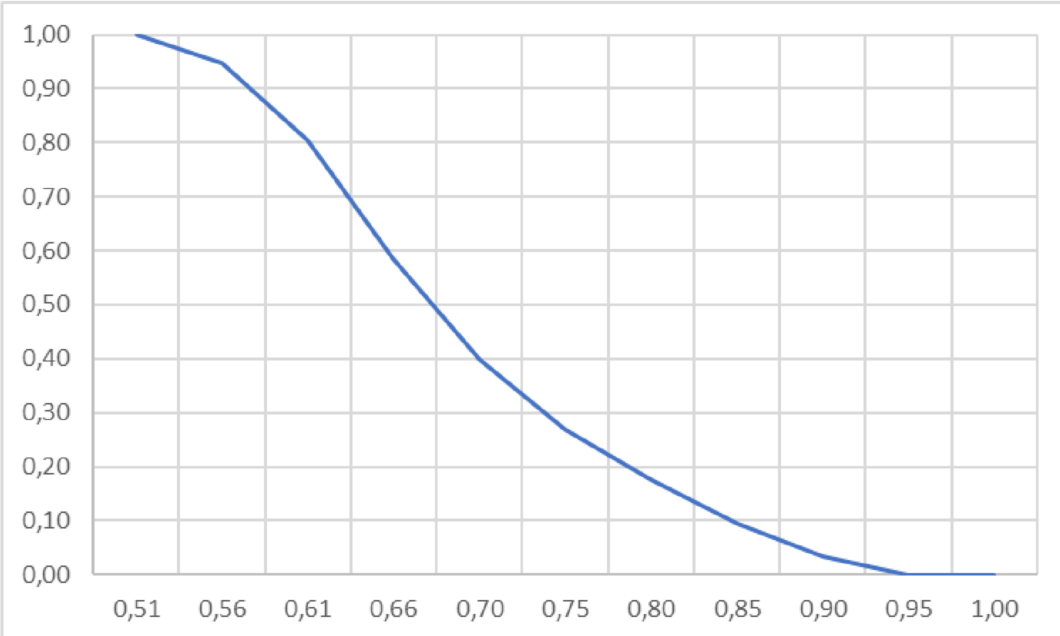
The fact that the region has characteristics of a young basin formed due to tectonic movements has led to high relief and incurred changes in slope values (Table 2.14).

Table 2.14. Hypsometric ratio values of the study area

Height (h)	**Maximum Height (H)**	**Area (Ha) Surface Area (a)**	**Basin Area (Ha) Surface Area (A)**	**Relative Height (h/H)**	**Relative Area (a/A)**
1137	2239	549,96	549,80	0,51	1,00
1247	2239	521,34	549,80	0,56	0,95
1357	2239	441,90	549,80	0,61	0,80
1468	2239	321,35	549,80	0,66	0,58
1578	2239	219,57	549,80	0,70	0,40
1688	2239	147,39	549,80	0,75	0,27
1798	2239	96,90	549,80	0,80	0,18
1908	2239	52,28	549,80	0,85	0,10
2019	2239	18,67	549,80	0,90	0,03
2129	2239	0,00	549,80	0,95	0,00
2239	2239		549,80	1,00	0,00

The basin is dominated by a concave-shaped hypsometric curve (Figure 2.23). This result indicates that the transported material decreases, the flow power in the rivers decreases, high water flow can be effective in the form of overflows, and deposition is more dominant.

Figure 2.23. Research area basin hypsometric curve graph



Conclusion

The study area has deep valleys, cornices, necks, fairy chimneys, and other landforms that are caused by fluvial processes. These landforms are made up of volcanic elements that have been surfaced by agglomerates, tuffs, and andesites. The fluvial effect developed in the topography as plateaus, mountainous areas, hills, and alluvial plains. The convex curvature of the rivers increases in the hilly areas, resulting in neck valleys.

Anthropogenic impacts have accelerated the processes affecting the geomorphology of the study area. Furthermore, the geomorphological features of the region have enabled the local people to use the area as site of cultural activity, which further increased erosion. For example, the tuffaceous terrain allowed it to be used for defense purposes, enabled the construction of religious elements (such as chapels, churches, etc.), and being used for humanly needs such as cellars or dwellings. Today, these landforms continue to be used as haylofts, store houses, and barns. All of these situations have contributed to the increasingly continuation of anthropogenic erosion in the area.

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